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DIVISION OF TIMBER MANAGEMENT
REGION 4 FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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Interim Report

# TRENDS OF A MOUNTAIN PINE BEETLE OUTBREAK IN A HIGH ELEVATION STAND IN YELLOWSTONE NATIONAL PARK

By Douglas L. Parker

## INTRODUCTION

The mountain pine beetle, Dendroctonus ponderosae Hopkins, outbreak in Yellowstone National Park is part of a massive infestation that started in low elevation lodgepole pine stands on the adjoining Targhee National Forest. The infestation reached the southwestern corner of the Park in 1966 and spread into higher elevation stands to the north and east in subsequent years.

Trends of the outbreak in the southwestern corner of the Park were measured in a 1-square-mile area from 1966 until the outbreak in that area subsided in 1972.1/ The information collected during this study improved our understanding of mountain pine beetle outbreaks, but more data are needed, especially for higher elevation stands.

## OBJECTIVE

The objective of this study is to determine annual losses caused by the mountain pine beetle from the beginning to the end of the outbreak in a stand above 8,000 feet elevation.

## STUDY AREA

Permanent plots were established in a 320-acre area between North and Middle Forks of Split Creek in the Park. This area was selected because there was a sawtimber size stand above 8,000 feet in elevation and yearly losses could be measured without the direct influences of timber harvesting.

## METHODS

Thirty-two half-acre rectangular plots (0.5 chains by 10 chains) were permanently established in a systematic pattern within the study area to measure yearly mortality. The center lines of plots were marked with stakes at 100-foot intervals. The boles of beetle killed and infested trees on the plots were marked by year of attack with metal tags at 4.5 feet above the ground. These plots will be measured yearly until the infestation subsides.

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1/ Parker, D. L., 1972. Trends of a mountain pine beetle outbreak in Yellowstone National Park, 1966-1972. Unpub. report. U.S. Dep. of Agr., Forest Service, Division of Timber Management, Ogden, Utah, 5pp., Illus.

Thirty-two variable point plots (10 basal area factor) were located systematically at 10-chain intervals to measure the stand structure. The plot center was marked with a stake and the nearest tree was marked with paint. These plots will be remeasured at the end of the infestation.

Each year following data collections, a report will be prepared and sent to all concerned agencies. A final report will be prepared to summarize the entire study after the outbreak ends.

## RESULTS AND DISCUSSION

In 1969, before the infestation reached the study area, there were 139.8 live trees per acre 5.5 inches in diameter and above (see computer summary sheet in Appendix). The stand composition by tree species and the number of trees per acre follows: Pinus contorta, 114.1; Abies lasiocarpa, 4.0; Picea engelmanii, 0.5; and Pinus albicaulis, 21.2. The "other" category on the non-host computer printouts in the Appendix applies to whitebark pines killed by the mountain pine beetle. Generally, the stand is decadent with heavy dwarf mistletoe and rot fungi infections. There are a large number of dead tops in the stand which provides a further indication of the condition of the stand (Figure 1, Appendix). Reproduction and pole size trees are abundant, but they occur in thick clumps and many trees are suppressed.

The mountain pine beetle killed 4.5 lodgepole pines and 0.4 whitebark pines per acre in 1970, 1971, and 1972 (see printouts in Appendix). Less than 4 percent of the total stand had been depleted by the mountain pine beetle in 1972. The infestation increased from 0.4 trees per acre in 1970 to 2.0 in 1971, but the level of mortality decreased to 1.7 in 1972.

An examination of the 1971 attacked trees showed that most (more than 50 percent) of the beetles had emerged, but most of the trees also contained hibernating adults. The mountain pine beetle generally requires one year to complete its life cycle; but at this high elevation, some of the insects require two years to complete their development.

Even though the level of tree killing decreased in the study area, mortality increased in nearby stands on the Targhee National Forest. Inflights of beetles from the adjacent infestation, as well as a population buildup from within, should cause an increase in mortality in 1973 in the study area.

Statistical analyses of between plot variation for the number of trees per acre for stand structure and mortality counts are included in the Appendix.

# APPENDIX

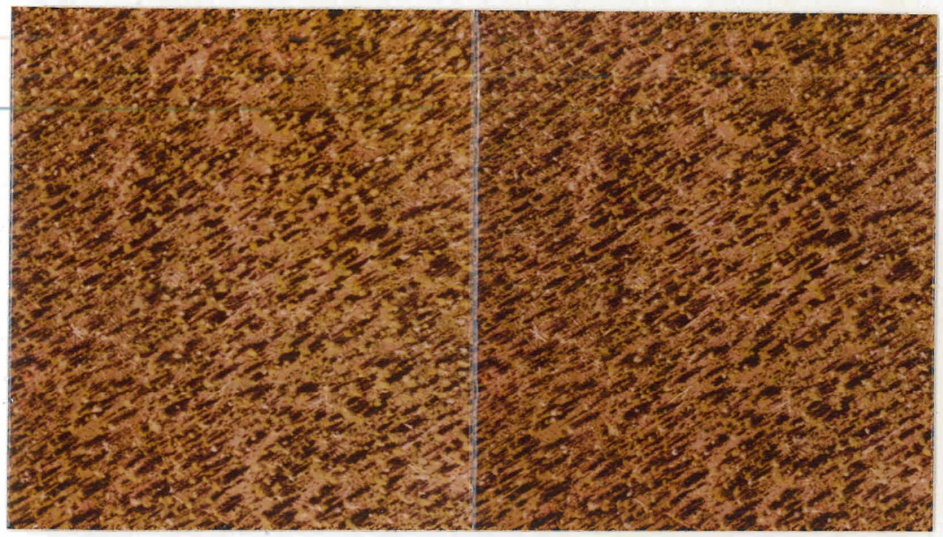

Figure 1. Stereogram of the decadent lodgepole pine, whitebark pine, subalpine fir, and spruce stand near the Split Creek study area in Yellowstone National Park, 1972. Most of the trees that appear dead (white-colored snags) are alive, but the tops are dead. The trees in the understory occur in thick clumps and they are suppressed.

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POPULATION STAND TABLE
YELLOWSTONE TREND PLOT 2
HOST SPECIES IS LODGEPOLE PINE

THE INSECT NAME IS MOUNTAIN PINE BEETLE

THE METHOD OF SAMPLING WAS VARIABLE THE FIGURES IN THIS TABLE ARE BASED ON A SAMPLE OF 32 PLOTS, AND REPRESENT AN AREA OF 320ACRES.

BAF WAS 10

THIS TABLE ONLY INCLUDES HOST TREES

NUMBERS OF TREES

PER ACRE

| DBH | LIVE | NEW | OLD | SNAG | TOT. DEAD | PERCT. DEAD | TOTAL | PERCENTILE |
|---|---|---|---|---|---|---|---|---|
| 5.5- 6.5 | 7.958 | 0 | 0 | 0 | 0 | 0 | 7.958 | 6.972 |
| 6.5- 7.5 | 7.016 | 0 | 0 | 0 | 0 | 0 | 7.016 | 6.148 |
| 7.5- 8.5 | 7.162 | 0 | 0 | 0 | 0 | 0 | 7.162 | 6.275 |
| 8.5- 9.5 | 8.488 | 0 | 0 | 0 | 0 | 0 | 8.488 | 7.434 |
| 9.5- 10.5 | 9.748 | 0 | 0 | 0 | 0 | 0 | 9.740 | 8.533 |
| 10.5- 11.5 | 10.891 | 0 | 0 | 0 | 0 | 0 | 10.891 | 9.541 |
| 11.5- 12.5 | 11.141 | 0 | 0 | 0 | 0 | 0 | 11.141 | 9.760 |
| 12.5- 13.5 | 10.171 | 0 | 0 | 0 | 0 | 0 | 10.171 | 8.911 |
| 13.5- 14.5 | 9.354 | 0 | .585 | 0 | .585 | 5.882 | 9.939 | 8.709 |
| 14.5- 15.5 | 11.265 | .255 | .255 | 0 | .509 | 4.348 | 11.714 | 10.263 |
| 15.5- 16.5 | 6.267 | 0 | .224 | 0 | .224 | 3.449 | 6.491 | 5.686 |
| 16.5- 17.5 | 5.353 | .198 | 0 | 0 | .198 | 3.571 | 5.551 | 4.864 |
| 17.5- 18.5 | 3.006 | 0 | 0 | 0 | 0 | 0 | 3.006 | 2.634 |
| 18.5- 19.5 | 1.270 | .159 | 0 | 0 | .159 | 11.111 | 1.428 | 1.251 |
| 19.5- 20.5 | 1.576 | .143 | 0 | 0 | .143 | 8.333 | 1.719 | 1.506 |
| 20.5- 21.5 | .520 | 0 | 0 | 0 | 0 | 0 | .520 | .455 |
| 21.5- 22.5 | .118 | 0 | 0 | 0 | 0 | 0 | .118 | .104 |
| 22.5- 23.5 | .217 | .108 | .108 | 0 | .217 | 50.000 | .433 | .380 |
| 23.5- 24.5 | .398 | .099 | 0 | 0 | .099 | 20.000 | .497 | .434 |
| 24.5- 25.5 | 0 | .092 | 0 | 0 | .092 | 100.000 | .092 | .080 |
| 28.5- 29.5 | .068 | 0 | 0 | 0 | 0 | 0 | .068 | .060 |
| TOTAL | 111.92 | 1.05 | 1.17 | 0 | 2.23 | 1.95 | 114.14 | 100.00 |
| PERCENT | 98.05 | .92 | 1.04 | 0 | 1.96 | | | |

BASAL AREA PER ACRE FOR HOST TREES

| LIVE | NEW | OLD | SNAG | TOT. DEAD | TOTAL |
|---|---|---|---|---|---|
| 96.2500 | 2.1875 | 1.5625 | 0 | 3.7500 | 100.0000 |

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STATISTICAL ANALYSIS FOR HOST TREES

YELLOWSTONE TREND PLOT 2

| | AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | UPPER LIMIT |
|---|---|---|---|---|---|---|
| LIVE | 111.91765 | 8.11836046E 01 | 1.43513693E 01 | 72.53870 | 3.12212092E 04 | 4.04060456E 04 |
| NEW | 1.05431 | 5.96409102E 00 | 1.05431230E 00 | 565.68542 | 9.31322575E-09 | 6.74759873E 02 |
| OLD | 1.17142 | 4.22183315E 00 | 7.46321712E-01 | 360.40273 | 1.36031757E 02 | 6.13677652E 02 |
| SNAG | 0 | 0 | 0 | .00000 | 0 | .0 |
| TOT. DEAD | 2.22573 | 7.64123974E 00 | 1.35079311E 00 | 343.31337 | 2.79980846E 02 | 1.14468844E 03 |
| TOTAL | 114.14338 | 7.99599098E 01 | 1.41350486E 01 | 70.05216 | 3.20026665E 04 | 4.10490976E 04 |

POPULATION STAND TABLE
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BAF WAS 10

THIS TABLE ONLY INCLUDES NON-HOST TREES

NUMBERS OF TREES PER ACRE

| DBH | ALPINE FIR | SPRUCE | WHITE BARK | OTHER | TOTAL | PERCENTILE |
|---|---|---|---|---|---|---|
| 8.5- 9.5 | .707 | 0 | 0 | 0 | .707 | 2.759 |
| 10.5- 11.5 | .947 | 0 | .474 | 0 | 1.421 | 5.540 |
| 11.5- 12.5 | .398 | 0 | .398 | 0 | .796 | 3.104 |
| 12.5- 13.5 | 1.017 | 0 | 0 | 0 | 1.017 | 3.967 |
| 13.5- 14.5 | .292 | 0 | .877 | 0 | 1.169 | 4.560 |
| 14.5- 15.5 | 0 | 0 | .255 | 0 | .255 | .993 |
| 15.5- 16.5 | .224 | 0 | 0 | 0 | .224 | .873 |
| 18.5- 19.5 | .159 | 0 | 0 | 0 | .159 | .619 |
| 19.5- 20.5 | .286 | 0 | .143 | 0 | .430 | 1.676 |
| 21.5- 22.5 | 0 | 0 | 0 | .118 | .118 | .462 |
| 22.5- 23.5 | 0 | .108 | 0 | 0 | .108 | .422 |
| 25.5- 26.5 | 0 | .085 | .085 | 0 | .170 | .661 |
| 28.5- 29.5 | 0 | .068 | 0 | 0 | .068 | .266 |
| 31.5- 32.5 | 0 | .056 | 0 | 0 | .056 | .218 |
| 32.5- 33.5 | 0 | .053 | 0 | .053 | .105 | .410 |
| 34.5- 35.5 | 0 | .047 | 0 | 0 | .047 | .182 |
| 36.5- 37.5 | 0 | .042 | 0 | 0 | .042 | .163 |
| TOTAL | 4.03 | .46 | 20.98 | .17 | 25.64 | 100.00 |
| PERCENT | 15.72 | 1.79 | 81.83 | .67 | 100.00 | |

BASAL AREA PER ACRE FOR NON-HOST TREES

| ALPINE FIR | SPRUCE | WHITE BARK | OTHER | TOTAL |
|---|---|---|---|---|
| 3.7500 | 2.1875 | 2.8125 | .6250 | 9.3750 |

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STATISTICAL ANALYSIS FOR NON-HOST TREES

YELLOWSTONE TREND PLOT 2

| | AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | ESTIMATED NO. OF TREES UPPER LIMIT |
|---|---|---|---|---|---|---|
| ALPINE FIR | 4.03070 | 7.95823344E 00 | 1.40683021E 00 | 197.44055 | 8.39637886E 02 | 1.74000922E 03 |
| SPRUCE | .45839 | 2.02889563E 00 | 3.58661465E-01 | 442.61759 | 3.19117490E 01 | 2.61455087E 02 |
| WHITE BARK | 20.98103 | 1.05795121E 02 | 1.87021119E 01 | 504.24182 | 7.29253388E 02 | 1.26986050E 04 |
| OTHER | .17099 | 7.23991260E-01 | 1.27984782E-01 | 423.40389 | 1.37626484E 01 | 9.56729091E 01 |
| TOTAL | 25.64111 | 1.05210982E 02 | 1.85988497E 01 | 410.32154 | 2.25352205E 03 | 1.41567458E 04 |

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STATISTICS FOR TOTAL STAND

YELLOWSTONE TREND PLOT 2

| AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | ESTIMATED NO. OF TREES UPPER LIMIT |
|---|---|---|---|---|---|
| 139.78449 | 1.36066575E 02 | 2.40533994E 01 | 97.34025 | 3.70339482E 04 | 5.24281238E 04 |

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STRIPS WERE .500 CHAINS WIDE.

THIS TABLE ONLY INCLUDES HOST TREES

NUMBERS OF TREES PER ACRE

| DBH | LIVE | NEW | OLD | SNAG | TOT. DEAD | PERCT. DEAD | TOTAL | PERCENTILE |
|---|---|---|---|---|---|---|---|---|
| 7.5- 8.5 | 0 | .063 | 0 | 0 | .063 | 100.000 | .063 | 1.538 |
| 8.5- 9.5 | 0 | .063 | 0 | 0 | .063 | 100.000 | .063 | 1.538 |
| 10.5- 11.5 | 0 | .125 | 0 | 0 | .125 | 100.000 | .125 | 3.077 |
| 11.5- 12.5 | 0 | .063 | .125 | 0 | .188 | 100.000 | .188 | 4.615 |
| 12.5- 13.5 | 0 | .125 | .063 | .063 | .250 | 100.000 | .250 | 6.154 |
| 13.5- 14.5 | 0 | .188 | 0 | 0 | .188 | 100.000 | .188 | 4.615 |
| 14.5- 15.5 | 0 | 0 | .500 | 0 | .500 | 100.000 | .500 | 12.308 |
| 15.5- 16.5 | 0 | .063 | .188 | 0 | .250 | 100.000 | .250 | 6.154 |
| 16.5- 17.5 | 0 | .188 | .500 | .125 | .813 | 100.000 | .813 | 20.000 |
| 17.5- 18.5 | 0 | .125 | .125 | .125 | .375 | 100.000 | .375 | 9.231 |
| 18.5- 19.5 | 0 | .188 | 0 | 0 | .188 | 100.000 | .188 | 4.615 |
| 19.5- 20.5 | 0 | .125 | .063 | .063 | .250 | 100.000 | .250 | 6.154 |
| 20.5- 21.5 | 0 | .125 | .125 | 0 | .250 | 100.000 | .250 | 6.154 |
| 21.5- 22.5 | 0 | .063 | .063 | 0 | .125 | 100.000 | .125 | 3.077 |
| 22.5- 23.5 | 0 | 0 | .125 | 0 | .125 | 100.000 | .125 | 3.077 |
| 23.5- 24.5 | 0 | .063 | .063 | 0 | .125 | 100.000 | .125 | 3.077 |
| 24.5- 25.5 | 0 | .063 | 0 | 0 | .063 | 100.000 | .063 | 1.538 |
| 27.5- 28.5 | 0 | .063 | .063 | 0 | .125 | 100.000 | .125 | 3.077 |
| TOTAL | 0 | 1.69 | 2.00 | .38 | 4.06 | 100.00 | 4.06 | 100.00 |
| PERCENT | 0 | 41.54 | 49.23 | 9.23 | 100.00 | | | |

BASAL AREA PER ACRE FOR HOST TREES

| LIVE | NEW | OLD | SNAG | TOT. DEAD | TOTAL |
|---|---|---|---|---|---|
| 0 | .8486 | 1.0232 | .1948 | 2.0666 | 2.0666 |

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STATISTICAL ANALYSIS FOR HOST TREES

YELLOWSTONE TREND PLOT 2

| | AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | UPPER LIMIT |
|---|---|---|---|---|---|---|
| LIVE | 0 | 0 | 0 | .00000 | 0 | 0 |
| NEW | 1.68750 | 3.17690761E 00 | 5.61603228E-01 | 188.26119 | 3.60286967E 02 | 7.19713033E 02 |
| OLD | 2.00000 | 2.43628485E 00 | 4.30678385E-01 | 121.81424 | 5.02182917E 02 | 7.77817083E 02 |
| SNAG | .37500 | 9.41858150E-01 | 1.66498571E-01 | 251.16217 | 6.72045725E 01 | 1.73279543E 02 |
| TOT. DEAD | 4.06250 | 5.06689127E 00 | 8.95708293E-01 | 124.72348 | 1.01337335E 03 | 1.58662665E 03 |
| TOTAL | 4.06250 | 5.06689127E 00 | 8.95708293E-01 | 124.72348 | 1.01337335E 03 | 1.58662665E 03 |

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STRIPS WERE .500 CHAINS WIDE.

THIS TABLE ONLY INCLUDES -HOST TREES

N U M B E R S  O F  T R E E S

P E R  A C R E

| DBH | 1972 HIT WB | 1971 HIT WB | | OTHER | TOTAL | PERCENTILE |
|---|---|---|---|---|---|---|
| 11.5- 12.5 | 0 | .063 | 0 | 0 | .063 | 14.286 |
| 13.5- 14.5 | .063 | | 0 | 0 | .063 | 14.286 |
| 14.5- 15.5 | .063 | | 0 | 0 | .063 | 14.286 |
| 15.5- 16.5 | 0 | .063 | 0 | 0 | .063 | 14.286 |
| 17.5- 18.5 | 0 | .063 | 0 | 0 | .063 | 14.286 |
| 21.5- 22.5 | 0 | .063 | 0 | 0 | .063 | 14.286 |
| 22.5- 23.5 | 0 | .063 | 0 | 0 | .063 | 14.286 |
| TOTAL | .13 | .31 | 0 | 0 | .44 | 100.00 |
| PERCENT | 28.57 | 71.43 | 0 | 0 | 100.00 | |

BASAL AREA PER ACRE FOR NON-HOST TREES

| 1972 HIT WB | 1971 HIT WB | | OTHER | TOTAL |
|---|---|---|---|---|
| .0457 | .1885 | 0 | 0 | .2342 |

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STATISTICAL ANALYSIS FOR -HOST TREES

YELLOWSTONE TREND PLOT 2

| | AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | ESTIMATED NO. OF TREES UPPER LIMIT |
|---|---|---|---|---|---|---|
| 1972 HIT WB | .12500 | 4.91869377E-01 | 8.69510430E-02 | 393.49550 | 1.21756663E 01 | 6.78243337E 01 |
| 1971 HIT WB | .31250 | 1.14828062E 00 | 2.02989254E-01 | 367.44980 | 3.50434388E 01 | 1.64956561E 02 |
| | 0 | 0 | 0 | .00000 | 0 | 0 |
| OTHER | 0 | 0 | 0 | .00000 | 0 | 0 |
| TOTAL | .43750 | 1.31829558E 00 | 2.33043935E-01 | 301.32470 | 6.54259407E 01 | 2.14574059E 02 |

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STATISTICS FOR TOTAL STAND

YELLOWSTONE TREND PLOT 2

| AVE. NO. OF TREES PER ACRE | STANDARD DEVIATION | STANDARD ERROR | COEFFICIENT OF VARIATION | ESTIMATED NO. OF TREES LOWER LIMIT | ESTIMATED NO. OF TREES UPPER LIMIT |
|---|---|---|---|---|---|
| 4.50000 | 5.25479811E 00 | 9.26925845E-01 | 116.77329 | 1.14274373E 03 | 1.73725627E 03 |